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Occupational exposure to body fluids among health care workers in Georgia

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Background	Health care workers (HCWs) are at increased risk of being infected with blood-borne pathogens.
Aims	To evaluate risk of occupational exposure to blood-borne viruses and determine the prevalence of human immunodeficiency virus (HIV), hepatitis B virus (HBV) and hepatitis C virus (HCV) among HCWs in Georgia.
Methods	The sample included HCWs from seven medical institutions in five cities in Georgia. A self-administered questionnaire was used to collect information on demographic, occupational and personal risk factors for blood-borne viruses. After obtaining informed consent, blood was drawn from the study participants for a seroprevalence study of HBV, HCV and HIV infections.
Results	There were 1386 participating HCWs from a number of departments, including surgery (29%), internal medicine (19%) and intensive care (19%). Nosocomial risk events were reported by the majority of HCWs, including accidental needlestick injury (45%), cuts with contaminated instruments (38%) and blood splashes (46%). The most frequent risk for receiving a cut was related to a false move during a procedure, reassembling devices and handing devices to a colleague. The highest proportion of needlestick injuries among physicians (22%) and nurses (39%) was related to recapping of used needles. No HIV-infected HCW was identified. Prevalence of HCV infection was 5%, anti-HBc was present among 29% with 2% being HBsAg carriers.
Conclusions	Data from this study can be utilized in educational programs and implementation of universal safety precautions for HCWs in Georgia to help achieve similar reductions in blood-borne infection transmission to those achieved in developed countries.
Key words	Blood-borne virus; contamination injury; developing country; needlestick.

Introduction

Health care workers (HCWs) who are exposed to blood and body fluids in the workplace are at risk of being infected with blood-borne pathogens, including human immunodeficiency virus (HIV), hepatitis B virus (HBV) and hepatitis C virus (HCV). Percutaneous exposure to a patient with an active infection with these viruses carries an estimated risk of transmission of 0.3% for HIV, 2% for HCV and 20% for HBV [1–3]. The increasing prevalence of HIV and HCV, and high prevalence of HBV among patients in Georgia, increases the risk of HCWs getting exposed to body fluids infected with these viruses, especially when blood and body fluid precautions are not followed routinely by all health workers. Routine pre-exposure vaccination of HCWs against HBV, the use of standard precautions to prevent exposure to blood and the use of post-exposure prophylaxis are recommended. The implementation of these recommendations has resulted in a sharp decline in the incidence of HBV infection among HCWs in the Western countries [4–5].

At this time, there are no vaccines for HCV and HIV. Thus, education and implementation of the principles of universal blood and body fluid precautions by HCWs are important in preventing occupational injuries that put HCWs at risk of being infected. However, these

precautions are sometimes difficult to implement [4–6].

A study of blood donors in Georgia found a high prevalence of HCV (7%) and HBV (3%) [7]. These prevalence estimates are higher than those among blood donors in the neighboring countries [7]. This indicates that HCWs in Georgia are at substantial risk of infection with HCV and HBV compared with those in the developed countries. Currently, there is no reporting system for occupational exposure of HCWs in Georgia, making it impossible to assess the risk of infection and to evaluate factors associated with occupational exposure.

In addition, there is no systematic workplace training of HCWs in health care-associated infections and universal safety precautions in Georgia. There is limited data on the awareness of blood-borne viruses among HCWs and on the level of knowledge of infection-control precautions in Georgia [8]. Protocols need to be adopted and implemented for the reporting and follow-up of percutaneous or permucosal exposures to blood or body fluids [9–10].

The aim of the study was to assess the risk of occupational exposure to blood-borne viruses, the use of routine barriers and the prevalence of HIV, HBV and HCV among Georgian HCWs.

Methods

In 2006–07, a cross-sectional, occupational survey of physicians and nurses was conducted in Georgia. The questionnaire included questions on occupational exposures (e.g. needlestick), behaviors and availability of barrier precautions (e.g. gloves, masks).

The study sample included HCWs (physicians, nurses and laboratory workers) from seven medical institutions in five cities in Georgia. These hospitals were chosen from Tbilisi, the capital of Georgia, two large cities in West Georgia and two large cities in East Georgia. The sample size estimation was based on the number of participants needed for hypothesized prevalence estimate of knowledge (75 poor knowledge) and prevalence ratios (PRs) for association between HCV risk factors and HCV prevalence (prevalence of HCV in low risk group of 5%, PR = 2); with type I error of 5% and power of 80%. The estimated sample size was approximately 1000. In total 1600 HCWs were approached to have sufficient sample size for some error in the estimates and an expected 20% non-response rate. Stratified (by hospital) random sampling was undertaken with the number selected from each hospital proportionate to its size. Within each hospital, study participants were selected by simple random sampling from the list of the staff in each hospital. Enrolment into the study continued until the designated number from each institution had been selected.

Potential study subjects were asked to participate in a private interview with a researcher. Informed and voluntary consent for participation was obtained from all study subjects prior to study enrolment. Approval by ethics committees in both Georgia and USA were obtained prior to the collection of data.

For all study participants, a self-administered questionnaire was used to obtain information on demographic characteristics, including gender, age and marital status. Also collected were professional characteristics, including position and year of graduation. Personal risk factors for exposure related to occupation were collected, such as the unit primarily assigned, frequency of medical procedures conducted, occupational behavior (e.g. recapping used needles, use of gloves) and the frequency and circumstances of specific incidences of contact with blood and body fluids; and use of barriers, such as gloves, masks and eyeglasses.

Venous blood was drawn for the seroprevalence study of antibodies to HBV, HCV and HIV infections. Third generation ELISA testing (manufacturer Orgenics, Israel) was done to determine HBsAg, anti-HBc, anti-HCV and anti-HIV status. ELISA seropositivity to HCV was confirmed by RIBA, and HBsAg positivity was confirmed by a neutralization assay.

Data management and statistical analyses were performed using SPSS 16.0. The descriptive analysis characterized the demographic and occupational data from the study population. Unadjusted associations between the outcome variables (HBV and HCV status and consistent glove use) and demographic and occupational characteristics were assessed by bivariate analysis. The χ^2 test was used for comparison. Risk factors for HCV, adjusted for other factors, were estimated using logistical regression. Consistent glove use was modelled with Poisson regression, using robust estimates for variance, to identify the contribution of various demographic and occupational factors in glove use among study participants, while controlling for all other factors. Comparisons were made using adjusted PR with associated 95% confidence intervals (CIs).

Results

Of the 1600 HCWs recruited, 1386 (87%) agreed to participate. Among the 1386 HCWs studied, 53% were nurses and 46% were physicians; 1100 (79%) were females and 283 (20%) were males. About 45% were 45 years of age and older, only 57 HCWs (4%) were 25 years of age and younger; 844 (61%) were married. The participating HCWs were from the departments of surgery (29%), internal medicine (19%) and intensive care (18%). The other HCWs were obstetricians and gynaecologists (15%), dialysis physicians and nurses (7%), paediatricians (7%) and laboratory workers (5%).

Nosocomial risk events were reported by the majority of HCWs, including accidental needlestick injury (45%,

with 20% reported of having more than five contaminated needlestick incidents), cuts with contaminated instruments (38%) and blood splashes (46%, with 15% reported of having five or more such incidents).

In bivariate analyses, males were more likely than females to report needlesticks (55% versus 43%, PR 1.3; 95% CI 1.1–1.5), blood splashes (65% versus 42%, PR 1.6; 95% CI 1.4–1.7) and cuts (56% versus 33%, PR 1.7; 95% CI 1.5–1.9). Physicians were more likely to report blood splashes and accidental cuts with contaminated instruments than nurses (blood splashes—55% versus 40%, PR 0.7; 95% CI 0.6–0.8 and cuts—42% versus 36%. PR 0.8; 95% CI 0.7–0.9).

Different types of events predominated in subjects working in different hospital departments. Blood splashes were most common among obstetricians and gynaecologists (70% had at least one episode, with 21% having five or more cases of blood splash); while surgeons had the highest frequency of cuts with a contaminated instrument—almost half of them reported at least one incident. The frequency of needlestick injuries was highest among dialysis physicians and nurses (58% reported a needlestick accident).

The highest frequency of cuts with a contaminated instrument occurred during a false move (e.g. hand slipped) during the procedure (71% of cuts among physicians and 63% among nurses), see Table 1. The next most frequent cause of cuts was reassembling devices (10% among both physicians and nurses) and handling a device used by a colleague (6 and 7%). The highest proportion of accidental needlestick injuries was attributed to a false move during a procedure (60% of accidents among physicians and 46% among nurses) and to the recapping of used needles (22% among physicians and 39% among nurses), see Table 2. Most blood splash events occurred during direct patient contact (87% among physicians and 81% among nurses).

The use of barrier precautions during patient contact was unusual, including use of gloves (only 32% reported of always using gloves), face masks (27% never used) and eye shields (76% never used). In bivariate analyses, the factors significantly associated with consistent glove use were gender (females using gloves more consistently than males), occupation (nurses using gloves more often than physicians) and type of job (the highest glove use rate was among obstetricians/gynaecologists, dialysis personnel and surgeons), see Table 1. In multivariate analysis, for always using gloves, only job type was significantly related when adjusted for other factors.

Only 29% of HCWs knew that needles should be placed in sharps containers after use, 23% thought that they should be recapped, 28% thought that they should be placed in disinfection solution, and 18% stated that they did not know the correct way to handle contaminated needles. The majority (75%) of HCWs reported that they did not know how endoscopic equipment should be cleaned.

None of the participating HCWs were infected with HIV. The overall prevalence of HCV infection was 5%; anti-HBc was positive among 29% of study participants, and 2% were HBsAg carriers. The prevalence differed significantly by city. HCV prevalence was 4, 4, 6, 8 and 12% ($P < 0.05$) in the five cities, where participating hospitals were located.

A history of occupational exposure, such as a blood splash, cut with a contaminated instrument and a needlestick injury, was not significantly associated with HBV and HCV infection status. The highest HCV prevalence was found in the 36–45 age group (8% infected). In contrast, HBsAg was most prevalent among the youngest HCWs—5% of those younger than 25 years of age were positive.

HCV infection status was significantly associated with occupation and gender (Table 3). Physicians were almost twice as likely to be infected with HCV as compared with nurses (PR = 1.8; 95% CI 1.1–3.0). Male HCWs were 2.7 times (95% CI 1.6–4.2) as likely to be infected with HCV as compared with nurses. In contrast, HBV

Table 1. Circumstances related to the occupational exposure to blood among HCWs, Georgia 2006–07

Exposure	Physicians *n* (%)	Nurses *n* (%)
Cut with contaminated instrument		
False move during procedure	135 (71)	107 (63)
Reassembling device	19 (10)	17 (10)
Device pierced bag/container	13 (7)	6 (4)
Colleague handled used device	11 (6)	11 (7)
Cleaning/disinfecting device	3 (2)	15 (9)
Cut with broken glass of tube with blood	3 (2)	5 (3)
Device left unattended	2 (1)	3 (2)
Other	3 (2)	4
Stuck with contaminated needle		
False move during procedure	127 (60)	120 (46)
Recapping the needle	47 (22)	101 (39)
Colleague handled used needle	11 (6)	17 (7)
Discarding the needle	8 (3)	14 (5)
Needle left unattended	7 (3)	4 (2)
Needle pierced bag/container	5 (2)	3 (1)
Blood splash		
Direct patient contact	190 (87)	113 (81)
Syringe with blood	14 (6)	16 (11)
Tube with blood	9 (4)	6 (4)
Other	5 (2)	5 (4)

Table 2. Demographic, occupational and medical factors related to systematic glove use among HCWs, Georgia, 2006–07

Exposure	Always using gloves		
	n (%)	Unadjusted PR and 95% CI	Adjusted PR and 95% CI
Anti-HCV +			
Yes	19 (27)	1	1
No	408 (32)	1.18 (0.79;1.73)	1.19 (0.78; 1.83)
Age			
≤35	314 (34)	1.19 (0.97; 1.45)	1.16 (0.96;1.41)
>35	87 (28)	1	1
Gender			
Females	351 (33)	1.26 (0.02; 1.56)	1.19 (0.93; 1.54)
Males	75 (27)	1	1
Occupation			
Physician	179 (29)	1	1
Nurse	247 (35)	1.21 (1.03; 1.42)	1.13 (0.94; 1.36)
Department			
Surgery	128 (34)	1.66 (1.08; 2.59)	1.89 (1.18; 3.02)
ICU	57 (23)	1.13 (0.71; 1.78)	1.21 (0.73; 2.00)
Dialysis	41 (44)	2.13 (1.34; 3.39)	2.39 (1.46; 3.92)
Internal medicine	59 (23)	1.13 (0.71; 1.79)	1.24 (0.76;2.04)
Lab	17 (28)	1.39 (0.79; 2.45)	1.32 (0.69; 2.52)
Obstetrician and gynaecologist	107 (52)	2.55 (1.68; 3.90)	2.69 (1.69; 4.28)
Paediatrics	19 (20)	1	1
Ever having blood splash			
Yes	224 (37)	1.31 (1.12; 1.54)	1.22 (1.02; 1.45)
No	192 (28)	1	1

infection was more prevalent among nurses (for HBsAg, PR = 2.6; 95% CI 1.1–6.0 and for anti-HBc, PR = 1.2; 95% CI 1.0–1.4). HCWs in the surgical department (6%) and ICU (6%) tended to have higher HCV rates than those in internal medicine (4%), but these differences were not statistically significant.

Discussion

The prevalence of HCV infection among Georgian HCWs was 5% in our study. The HCV prevalence varied between different cities, with the lowest being 4% and the highest being 12%. This variation could be explained by the different measures of HCV prevalence in the communities where the hospitals are located; however, in this study, the HCV prevalence in the communities is unknown outside the capital city.

In developed countries, a significant reduction of blood-borne virus transmission was achieved in the late 1980s following wide scale educational programs and implementation of universal safety precautions [11–13]. The prevalence estimates from our study are higher than those reported by most other studies conducted in developed as well as developing countries [14–17]. An Albanian study found that only 0.6% of HCWs tested were HCV positive [18]. Among more than 10 000 Scottish HCWs enrolled in an HCV seroprevalence study, 0.3% had HCV antibodies [19]. Among Japanese HCWs, HCV prevalence was 3% and was similar across various occupational groups; unlike our results, where HCV prevalence differed by department and occupational categories [20]. This might suggest that the high prevalence of HCV antibodies among HCWs in Japan reflected the community prevalence rather than exposures to contaminated blood from patients at the worksite.

In our study, the prevalence of hepatitis C was higher among surgeons and ICU personnel as compared with HCWs from internal medicine departments; however, the difference was not statistically significant. Studies from developed countries show the opposite. The authors of one German study pointed out that while the frequency of needlestick injuries is highest among surgeons, internal medicine physicians and nurses are actually at a higher risk of acquiring blood-borne infections, because the prevalence of HIV, HBV and HCV is highest among their patients [21]. The study conducted in Scotland found no difference in HCV prevalence among HCWs performing high-risk procedures (such as surgeons) as compared with those who did not [22].

Needle recapping is one of the most important risk factors associated with needlestick injuries [23–25]. Consequently, a simple intervention to mitigate this risk hinges on educating HCWs about the risk associated with recapping used needles. Our study found that one in

Table 3. Demographic and occupational characteristics of HCWs by hepatitis markers, Georgia, 2006–07

Exposure	Anti-HCV (+)		HBsAg (+)		Anti-HBc (+)	
	n (%)	PR and 95% CI	*n* (%)	PR and 95% CI	*n* (%)	PR and 95% CI
Age						
<25	1 (1.8)	0.38 (0.05; 2.72)	3 (5.3)	2.54 (0.74; 8.61)	17 (30)	0.96 (0.63; 1.45)
25–35	10 (3.9)	0.84 (0.41; 1.69)	6 (2.3)	1.12 (0.43; 2.92)	61 (24)	0.76 (0.59; 0.97)
36–45	27 (7.8)	1.68 (1.01; 2.80)	6 (1.7)	0.83 (0.32; 2.18)	103 (30)	0.95 (0.78; 1.16)
>45	29 (4.6)	1	13 (2.1)	1	197 (32)	1
Gender						
Males	28 (9.9)	2.65 (1.67; 4.22)	5 (1.8)	0.84 (0.32; 2.20)	92 (33)	1.13 (0.93, 1.37)
Female	41 (3.7)	1	23 (2.1)	1	317 (29)	1
Marital status						
Married	48 (5.5)	1.14 (0.65; 1.98)	10 (1.2)	0.33 (0.14; 0.76)	252 (30)	1.10 (0.90; 1.35)
Single	16 (4.8)	1	12 (3.6)	1	90 (27)	1
Widowed	0 (0)	0	5 (4.7)	1.30 (0.47; 3.61)	35 (33)	1.20 (0.87; 1.66)
Divorced	6 (6.5)	1.35 (0.54; 3.34)	0 (0)	0	30 (33)	1.20 (0.85;1.68)
Occupation						
Nurse	26 (3.5)	0.55 (0.34; 0.88)	21 (2.8)	2.55 (1.11; 6.04)	237 (32)	1.20 (1.01; 1.42)
Physician	41 (6.4)	1	7 (1.1)	1	169 (27)	1
Department						
Surgery	23 (5.7)	1.40 (0.64; 3.12)	5 (1.2)	0.55 (0.17; 1.78)	130 (32)	1.29 (1.00; 1.66)
ICU	15 (5.9)	1.43 (0.67; 3.05)	7 (2.8)	1.22 (0.42; 3.59)	80 (31)	1.25 (0.94; 1.65)
Dialysis	5 (5.3)	1.29 (0.46; 3.61)	2 (2.1)	0.94 (0.19; 4.59)	40 (43)	1.70 (1.24; 2.34)
Internal medicine	11 (4.1)	1	6 (2.3)	1	64 (25)	1
Lab	1 (1.5)	0.36 (0.05; 2.75)	2 (3)	1.32 (0.27; 6.41)	18 (27)	1.07 (0.69; 1.68)
Obstetrician and gynaecologist	11 (5.4)	1.30 (0.57; 2.93)	5 (2.4)	1.08 (0.33; 3.49)	63 (31)	1.23 (0.91; 1.65)
Paediatrics	3 (3.2)	0.77 (0.22; 2.71)	1 (1.1)	0.47 (0.06; 3.87)	14 (15)	0.60 (0.35; 1.01)
Ever having blood splash						
Yes	32 (5.2)	1.19 (0.74; 1.93)	15 (2.1)	0.92 (0.44; 1.96)	192 (31)	1.12 (0.94; 1.32)
No	31 (4.3)	1	12 (1.9)	1	196 (28)	1
Ever having needle-stick injury						
Yes	31 (5.1)	1.25 (0.76, 2.04)	9 (1.5)	0.57 (0.26; 1.26)	160 (27)	0.86 (0.73; 1.02)
No	30 (4.1)	1	19 (2.6)	1	227 (31)	1
Ever having cut with contaminated instrument						
Yes	25 (5)	1.04 (0.64, 1.70)	13 (2.6)	1.50 (0.71; 3.18)	157 (31)	1.11 (0.94; 1.31)
No	39 (4.8)	1	14 (1.7)	1	229 (28)	1
Ever having gonorrhoea						
Yes	1 (7.1)	1.48 (0.22; 9.95)	2 (14.3)	7.47 (1.95; 28.54)	7 (50)	1.70 (1.00, 2.89)
No	13 (4.8)	1	25 (1.9)	1	382 (29)	1

five HCWs believes recapping needles is an appropriate and safe practice. Despite the multiple studies highlighting the risk, it remains difficult to change this hazardous activity in many developing countries. In a Polish study, 64% of respondents reported occasionally recapping the needles after injections [26]. An Egyptian study found that the most common circumstance causing an accidental needlestick injury is two-handed recapping [27].

Only 28% of surveyed HCWs correctly identified the proper method of handling used needles/devices. This is also consistent with reports from other developing countries. An Egyptian study found that the majority of HCWs (64%) are not following the rules for safely disposing used needles/syringes [27]. A study conducted in India found that the majority of sharps injuries happen while handling garbage bags [28].

The proportion of HCWs always using gloves during medical procedures was 32%. This is much lower than the glove use rate in developed countries, even a decade ago or earlier. In 1991, one such study of 26 US

medical facilities found that 70–92% of HCWs always used gloves for selected medical procedures [29].

A limitation of this study was that all safety precaution compliance data were self reported. The reliability of self-reported data may sometimes be low as a result of under-reporting due to social desirability issues. Nevertheless, the subjects in our study reported frequently following high risk procedures, and their seroprevalence of HCV and HBV was quite high. No direct observations were made in this study to validate the self-reported data on compliance with barrier precautions and frequency of occupational injuries. Based on anecdotal observations, it is difficult to believe that even the low levels of compliance with universal precautions are accurate. Thus, misclassification may be an important limitation in measuring associations. Further, it is clear that change in personal risk behaviors is an important confounder in the assessment of occupational risk of infection.

Data from this study can be utilized to design educational programs for HCWs. In developed countries, a significant reduction of blood-borne infection transmission was achieved following wide scale educational programs and implementation of universal safety precautions [30]. In addition to educational programs, it is important to develop a recommendation or regulatory framework for health clearance for blood-borne viruses among HCWs who perform exposure-prone procedures.

Key points

- There is a high prevalence of hepatitis B and C in health care workers in Georgia.
- Occupational exposure to blood and other body fluids was reported by the majority of health care workers, including accidental needlestick injury, cuts with contaminated instruments and blood splashes.
- The highest proportion of needlestick injuries among health care workers was related to recapping of used needles.

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Conflicts of interest

None declared.

References

1. Henderson DK, Fahey BJ, Willy M, *et al.*. Risk for occupational transmission of human immunodeficiency virus type1 (HIV1) associated with clinical exposures. A prospective evaluation. *Ann Intern Med* 1990;**113:** 740–746.
2. Gerberding JL. Incidence and prevalence of human immunodeficiency virus, hepatitis B virus, hepatitis C virus, and cytomegalovirus among health care personnel at risk for blood exposure: final report from a longitudinal study. *J Infect Dis* 1994;**170:**1410–1417.
3. Beltrami EM, Williams IT, Shapiro CN, Chamberland ME. Risk and management of blood-borne infections in health care workers. *Clin Microbiol Rev* 2000;**13:**385–407.
4. Stevens AB, Coyle PV. Hepatitis C virus: an important occupational hazard? *Occup Med (Lond)* 2000;**50:** 377–382.
5. CDC. Perspectives in disease prevention and health promotion update: universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus, and other bloodborne pathogens in health-care settings. *MMWR* 1988;**27:**377–388.
6. CDC. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HBV, HCV, and HIV and recommendations for postexposure prophylaxis. *MMWR* 2001;**50:**1–42.
7. Butsashvili M, Tsertsvadze T, McNutt LA, Kamkamidze G, Gvetadze R, Badridze N. Prevalence of HIV, HCV, HBV and syphilis in Georgian blood donors. *Eur J of Epidemiol* 2001;**17:**693–695.
8. Butsashvili M, Kamkamidze G, Umikashvili L, Gvinjilia L, Kankadze K, Berdzuli N. Knowledge of health care-associated infections among Georgian obstetricians and gynecologists. *J Infect Dev Ctries* 2010;**4:**329–333.
9. CDC. *NIOSH alert: preventing needlestick injuries in health care settings*. Cincinnati, OH: Department of Health and Human Services, 1999.
10. CDC. Recommendations for prevention of HIV transmission in health-care settings. *MMWR* 1987; **36**(Suppl. 02)**:**001.
11. CDC. Recommendations for prevention of HIV transmission in healthcare settings. *MMWR* 1987;**36:**S1–S18.
12. Haiduven DJ, DeMaio TM, Stevens DA. A five-year study of needlestick injuries: significant reduction associated with communication, education and convenient placement of sharps containers. *Infect Control Hosp Epidemiol* 1992;**13:**265–271.
13. Occupational Safety and Health Administration. Occupational exposure to bloodborne pathogens: final rule. *Fed Regist* 1991;**56**. 29 CFR Part 1910.1030.
14. Marconi A, Candido S, Talamini R, *et al.* Prevalence of hepatitis C virus infection among health-care workers: A 10-year survey. *Mol Med Report* 2010;**3:**561–564.
15. Khan S, Attaullah S, Ayaz S, *et al.* Molecular epidemiology of HCV among health care workers of Khyber Pakhtunkhwa. *Virol J* 2011;**8:**105.
16. Paraná R, Paiva T, Leite MR, *et al.* Infection with hepatitis C virus among health care workers in the Brazilian Western Amazon region (Rio Branco, State of Acre). *Am J Trop Med Hyg* 2007;**76:**165–169.

17. Jindal N, Jindal M, Jilani N, Kar P. Seroprevalence of hepatitis C virus (HCV) in health care workers of a tertiary care centre in New Delhi. *Indian J Med Res* 2006;**123:**179–180.
18 Kondili LA, Ulqinaku D, Hajdini M, *et al.* Hepatitis B virus infection in health care workers in Albania: a country still highly endemic for HBV infection. *Infection* 2007;**35:**94–97.
19 Thorburn D, Dundas D, McCruden EA, *et al.* A study of hepatitis C prevalence in healthcare workers in the West of Scotland. *Gut 2001*;**48:**116–120.
20 Miyajima I, Sata M, Murashima S, *et al.* Prevalence of hepatitis C antibodies in health care personnel. *Kansenshogaku Aasshi* 1997;**71:**103–107.
21. Wicker S, Jung J, Allwinn R, Gottschalk R, Rabenau HF. Prevalence and prevention of needlestick injuries among health care workers in a German university hospital. *Int Arch Occup Environ Health* 2008;**81:**347–354.
22. Rele M, Mathur M, Turbadkar D. Risk of needle stick injuries in health care workers – a report. *Indian J Med Microogy* 2002;**20:**206–207.
23. Smith DR, Mihashi M, Adachi Y, Nakashima Y, Ishitake T. Epidemiology of needlestick and sharps injuries among nurses in a Japanese teaching hospital. *J Hosp Infect* 2006;**64:**44–49.
24. Nagao Y, Baba H, Torii K, *et al.* A long-term study of sharps injuries among health care workers in Japan. *Am J Infect Control* 2007;**35:**407–411.
25. Norsayani MY, Noor HI. Study on incidence of needle stick injury and factors associated with this problem among medical students. *J Occup Health* 2003;**45:**172–178.
26. Bilski B. Needlestick injuries in nurses – the Poznań study. *Int J Occup Med Environ Health* 2005;**18:**251–254.
27. Talaat M, Kandeel A, El-Shoubary W, *et al.* Occupational exposure to needlestick injuries and hepatitis B vaccination coverage among health care workers in Egypt. *Am J Infect Control* 2003;**31:**469–474.
28. Salelkar S, Motghare DD, Kulkarni MS, Vaz FS. Study of needle stick injuries among health care workers at a tertiary care hospital. *Indian J Public Health* 2010;**54:**18–20.
29. Kaczmarek RG, Moore RM, Jr, McCrohan J, *et al.* Glove use by health care workers: results of a tristate investigation. *Am J Infect Control* 1991;**19:**228–232.
30. Elliott SK, Keeton A, Holt A. Medical students' knowledge of sharps injuries. *J Hosp Infect* 2005;**60:**347–347.